Left Alice Tully Hall's new face exposes the lobby, and Juilliard's new floors, to Broadway.

Alice Tully Hall and The Juilliard School

The warp and weft of a cantilevered steel addition hits a high note for audiences and performers.

ALTHOUGH IT IS ONE OF THE most often used venues in Lincoln Center, Alice Tully Hall hadn't had a renovation since its opening night in 1969. And though The Juilliard School surrounding it had never faltered in its ability to develop world-famous performing artists, it was in much need of a makeover that would add practice rooms, classrooms, and office spaces. The long-overdue redesign, undertaken by Diller Scofidio + Renfro in collaboration with FXFowle Architects in 2003 and to be completed this year, strips away the opaque facade at the base of Pietro Belluschi's original scheme, revealing the entrance lobby and Juilliard's inner workings to the street. The dramatic physical, and symbolic, gesture was made possible by Arup's structural engineers, who developed a 50-foot steel truss cantilever that serves the dual purpose of creating a soaring entrance to Alice Tully Hall while expanding the school's practice space overhead.

Like the pieces performed there, the project was complex and multilayered. A tight urban site is adjacent to the subway, and a schedule accelerated to meet performance and academic year deadlines—even as the school remained fully operational during construction—presented significant challenges. Despite these, the new space is marked by a transparent, column-free lobby created by a unique geometry of intersecting tilted planes defined

Previous spread and this spread: Iwan Baan

by the building's north and south elevations, its Broadway property line, and a sloped and tilted soffit. "We talked about doing a big gesture, in the spirit of the big volumes of the building," says Sylvia Smith, senior partner in charge of the project for FXFowle, of the team's initial design meetings. The resulting shape reaches toward Broadway, creating a welcoming space that beckons visitors inside.

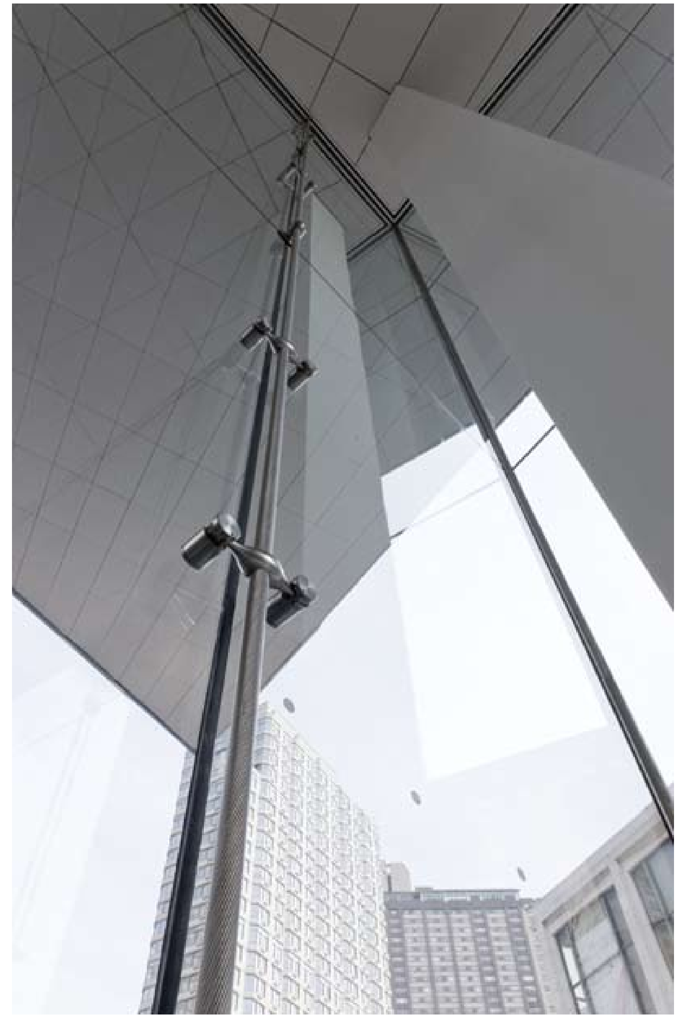
To achieve the dramatic visual and philosophical change Lincoln Center wished for, the architects designed two curtain wall systems that give the building transparency by minimizing the visibility of cables, fittings, and component transitions. For Alice Tully's lobby curtain wall, a one-way pretensioned cable wall system and large single-glazed panels minimize the number of fittings used. According to Matt Larson, senior structural engineer for Arup, the challenge to the structure is for it to resist the amount of tension exerted by the stainless steel cables because they are sensitive to building movements. The Arup team utilized a closed loop structural system analogous to a tennis racquet. Through bending of the structural elements at the head and base of the wall, the tension in the cable wall is converted to compression in the lobby columns; the cumulative load at the head is used to resist the uplift at the base. The heads of the cables are anchored between a pair of stiff ASTM A992 Grade 50 wide-flange beams that span between the lobby columns. The W24 members meet both strength and stringent deflection requirements under high pretension loads. At the base, uplift on the cables is resisted by the foundation wall spanning between the lobby columns.

Where the lobby curtain wall turns the corner on 65th Street, the facade migrates away from the main structural line and drops vertically with the sloping soffit of the expansion. Immediately south of lobby volume, the structure must support facade cables that are as much as 12 feet eccentric to the support without the benefit of a back span. The engineers utilized a system of A992 Grade 50 W14x132 outriggers that cantilever off of ASTM A53 Grade B 24-inch diameter by 1-inch-thick pipe. Bending in the outriggers is transferred in torsion by the pipe to reinforced members in the existing building frame and to members in the expansion. Challenging welds and stringent construction tolerances at the cable attachments led the structural steel erector/fabricator Metropolitan-Walters to shop fabricate the entire assembly as a single piece.

Above the three-story lobby, a hung glass-fin wall on the east elevation of the building's cantilevered portion provides natural light to the Juilliard School spaces during the day, and is washed with lights at night creating, in Smith's words, "an illuminated jewel box." For this section, the goal was to not have any visible exterior fittings, but also to have high transparency for occupants looking out. To achieve this look, the entire 48-foot-high curtain wall system is hung from a 30-inch box-shaped girder with $1\frac{5}{8}$x12-inch flanges. Special alloy stainless steel tension rods are concealed between insulating glass units to pick up the dead loads hanging from above. Despite spanning as much as 67 feet to doubly cantilevered support points (the box beam sits on beams that cantilever from the end of the cantilevered trusses), Arup was able to limit the differential deflection of the hollow structural section to 2mm per 5-foot bay. This was required to prevent the glazing edge from hitting the concealed rods. Concealed glazing clips at vertical joints transfer wind load to the glass fins via structural silicone glazed aluminum extrusions, and due to fabrication limitations for fin length, glass-to-glass splicing was used to avoid the visual disruption of typical metal splice connections.

Its curtain walls may expose the building's beauty, but its 275-ton system of steel trusses attests to equal endowments of brains and brawn. The trusses allow for the 50-foot cantilever to the property line, preserving exterior plaza spaces, and also for a 75-foot unsupported back span that supports as many as four stories on a single truss and creates a large, unobstructed lobby space with only three visible columns. Moreover, the steel design enabled the architects and engineers to deal with the technically demanding program in which they created a four-story expansion extending from the existing structure, whose elevations were not always at the same height. In addition to simplifying connections between new space and the original steel-frame building, the team could tightly control the geometry of custom shop-built steel assemblies to meet needs for dense mechanical distribution, theater lighting, electrical, high-tech audio-visual infrastructure as well as minimal architectural finish clearances.

Although creating a welcoming gesture was the outward design goal, the need for ideal performance spaces that were isolated acoustically from one another determined the building's framework. Steel tonnage was driven higher by the need to support solid CMU acoustic partitions, isolated acoustic concrete topping slabs, and heavy acoustic ceilings in sound-sensitive spaces for rehearsal, recording, and performance. The increased loads also required column strengthening at the interface between the new and existing buildings, where existing wide-flange columns were plated with ASTM A572 Grade 50 reinforcing plates up to $3\frac{3}{4}$ inches thick. The lateral system for the expansion was achieved by infilling north-to-south bracing in the easternmost existing column line and with three braced frames (one north to south and two east to west) in the expansion structure; the diagonal brace along the southern facade is the only exposed brace element. Duct sizes also had to be larger to contain slower-moving (and thus quieter) air, but ducts were carefully woven around the structure to maintain ceiling heights.



Facing A 50-foot steel truss cantilever creates the soaring three-story lobby in addition to expanding office space and practice rooms for the school.

Above The one-way pretensioned cable wall system uses a minimum number of fittings while resisting cantilever movements overhead.

Above Steel framing simplified connections between the new building and the original steel-frame building. Large rehearsal and performance spaces are interwoven with small practice rooms and offices, throughout which steel members are kinked to bear the building's loads while accommodating acoustical material, electrical theater equipment, and large ductwork.

Facing The 100,000-square-foot structure, with its new elongated form, is meant to create a welcoming gesture to the public.

The building's unique steel "warp and weft" allowed the architects to weave so many varied spaces into the 100,000-square-foot structure.

FXFowle Architects

Iwan Baan

Seven trusses are positioned in smaller offices and practice rooms on varying floors of the cantilevered Juilliard School space to accommodate the larger spaces required by the dance studio, a double-height black box theater, and the double-height jazz rehearsal room. Truss chords were kinked in specific areas to allow passage through the story-tall trusses, fabricated from W14 wide flange sections with maximum chord and diagonal sizes of W14x730. In select areas, steel connections were designed in very tight coordination with the architectural clearance by adjusting gusset plates or using welded connections to maximize usable space.

Steel members also had to be located to fit with miscellaneous metal assemblies like the theater lighting grid, catwalks, and multiple ceiling plane levels. Numerous steel and slab elevation changes and ramps allow these larger spaces to mesh with the existing building's floor-to-floor elevations, as well as to accommodate various acoustic and performance floor build-ups throughout the expansion.

According to Smith, it is the building's unique steel "warp and weft" that enabled the architects to weave so many varied spaces into the 100,000-square-foot structure, replacing the somewhat detached Belluschi design with a brightly lit tableau. Seen at night, the transparent building almost resembles a page of sheet music come alive as teachers and students, performers and audience members, rise and descend through its levels, honoring Lincoln Center's history while creating a new image of its future. **M**

ALICE TULLY HALL AND THE JUILLIARD SCHOOL

Location: **1941 Broadway, New York, NY**
Architects: **Diller Scofidio + Renfro**, *New York, NY*,
in collaboration with **FXFOWLE Architects**, *New York, NY*
Structural Engineer: **Arup**, *New York, NY*
Mechanical Engineer: **Arup**, *New York, NY*
Miscellaneous Metals Engineer: **Anastos Engineering Associates**, *New York, NY*
General Contractor: **Turner Construction Company**, *New York, NY*
Curtain Wall Consultant: **R.A. Heintges & Associates**, *New York, NY*
Structural Steel Fabricator and Erector:
Metropolitan Walters, LLC, *New York, NY*
Miscellaneous Iron Fabricator and Erector:
Post Road Iron Works, Inc., *Greenwich, CT*
Ornamental Metal Fabricator and Erector:
Post Road Iron Works, Inc., *Greenwich, CT*;
Metal Teck, Inc., *Bensalem, PA*
Curtain Wall Fabricator and Erector: **W&W Glass**, *Nanuet, NY*